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(54) Sealing device for parts rotating relative to one another

(57) A sealing device for sealing the space between two parts (3, 4) rotating relative to one another, has a sealing element (1, 2) which is arranged between the parts and which surrounds the inner part (3). The sealing element (1, 2) is in the form of a part which surrounds the inner part (3) in the form of a closed ring and which is arranged to be movable in the radial direction relative to the outer part (4). In particular, the sealing element (1, 2) comprises a brush seal (2) and a seal carrier (1) for holding the brush seal (2) on the outer part (4), the seal carrier (1) being arranged to be movable in the radial direction. The carrier abuts element 9 for axial location and has slide elements 5 that extend from it and engage between guide elements 6 on part 4. The guide elements give circumferential location and allow radial sliding. The sealing device is used to seal spaces between parts of a jet propulsion unit, especially between the rotor and guide blades of the jet propulsion unit.

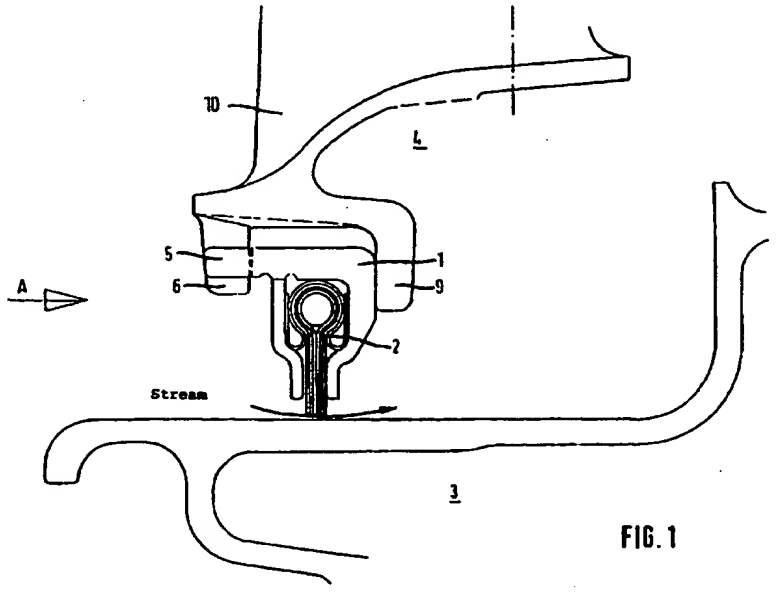

FIG. 1

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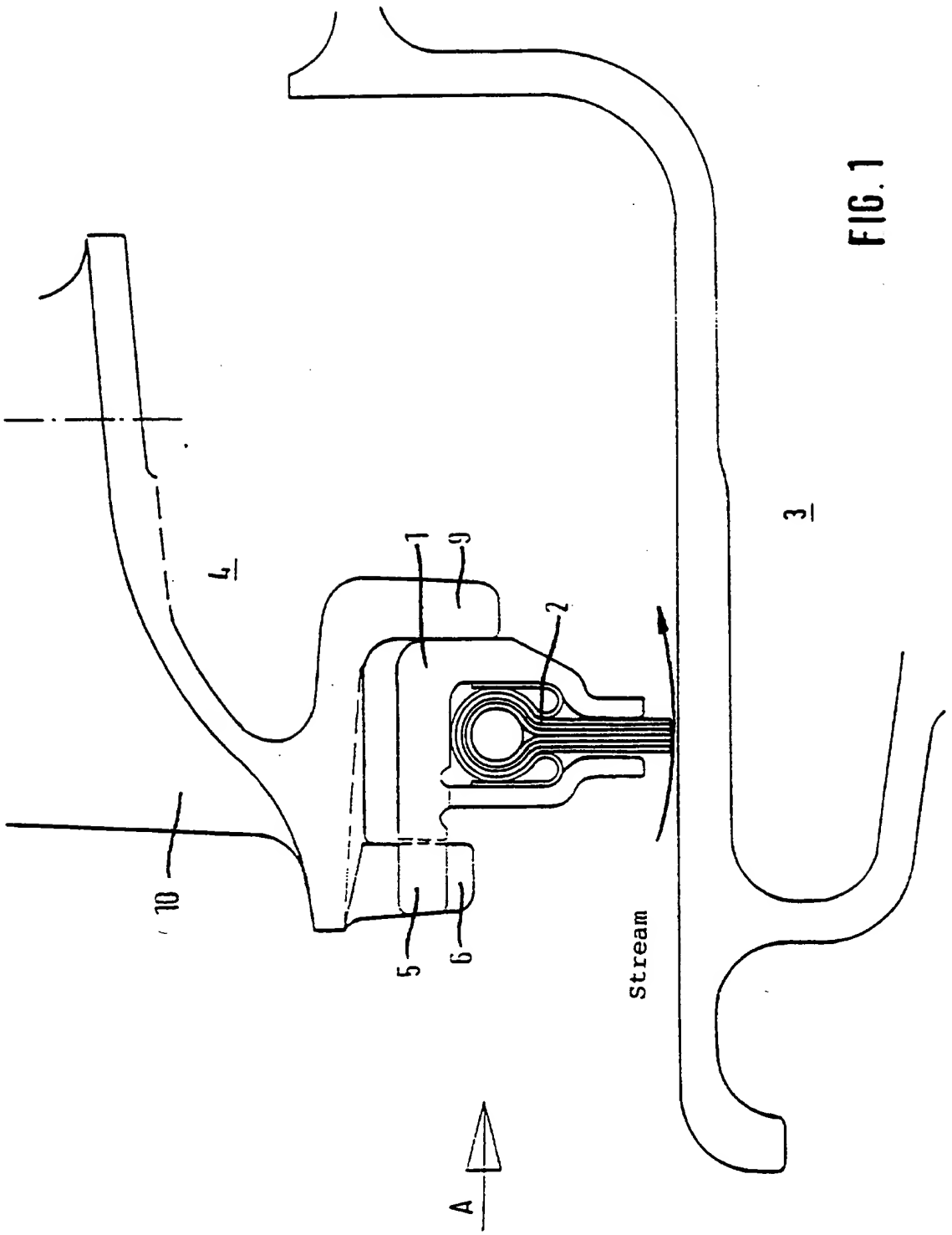

FIG. 1

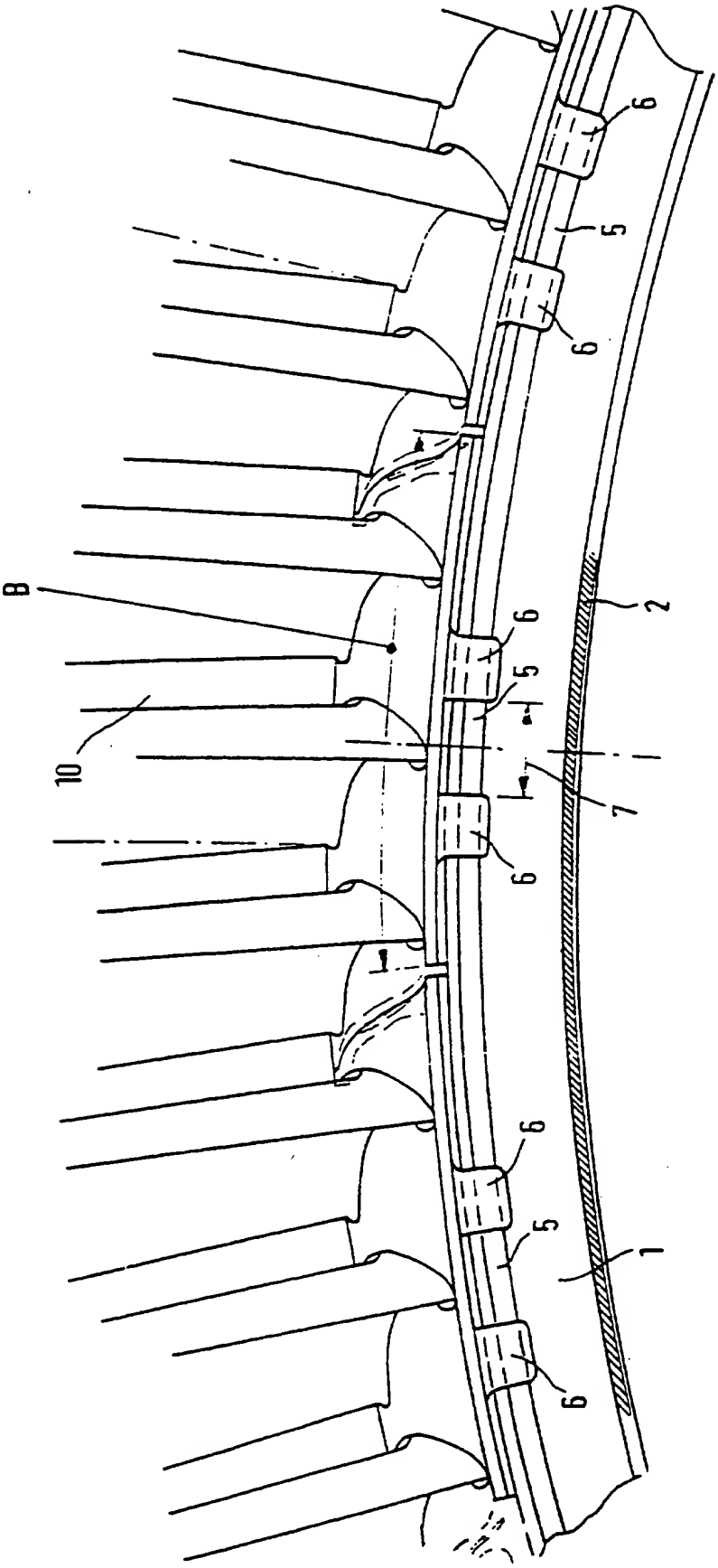

FIG. 2

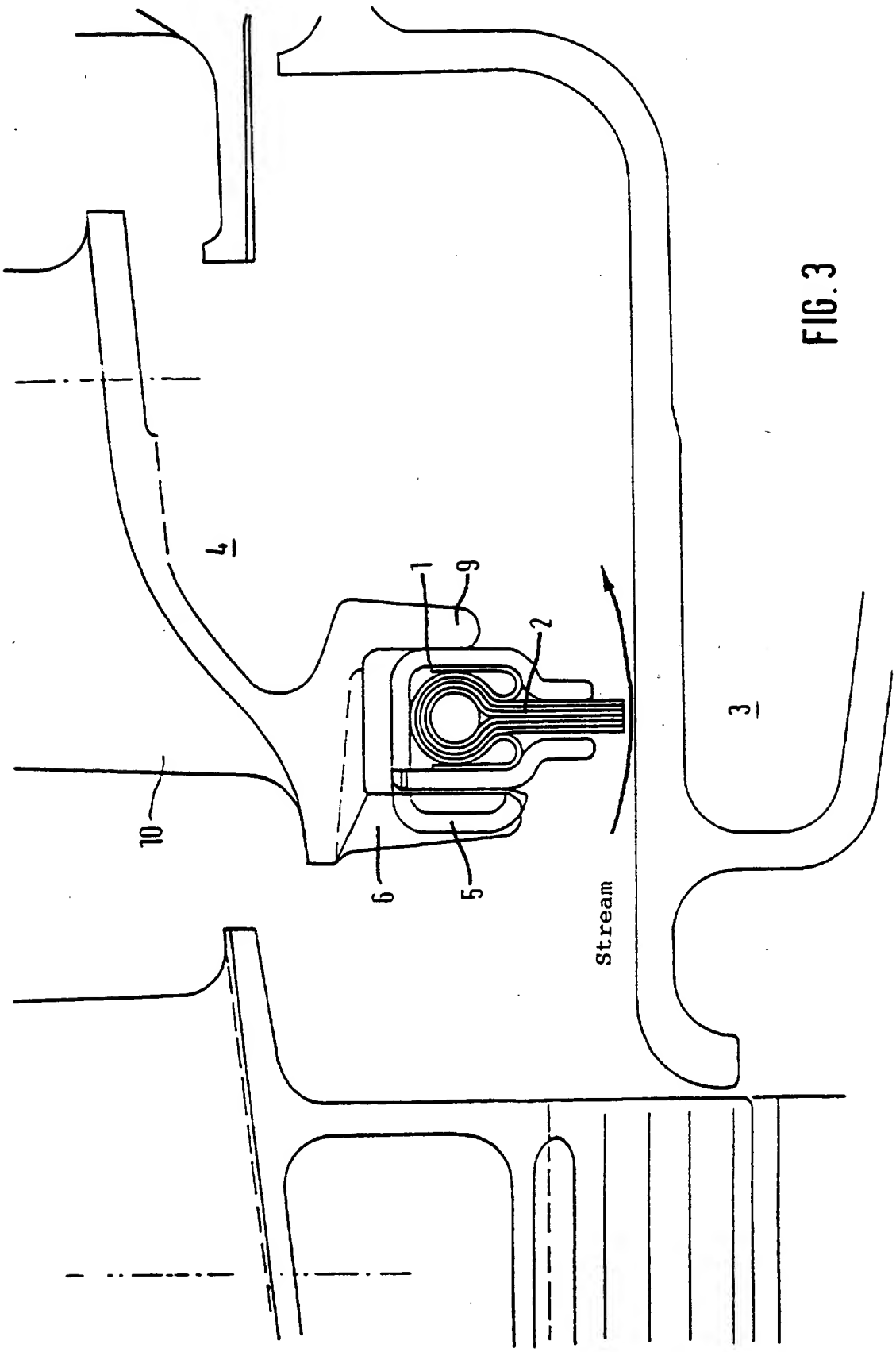

FIG. 3

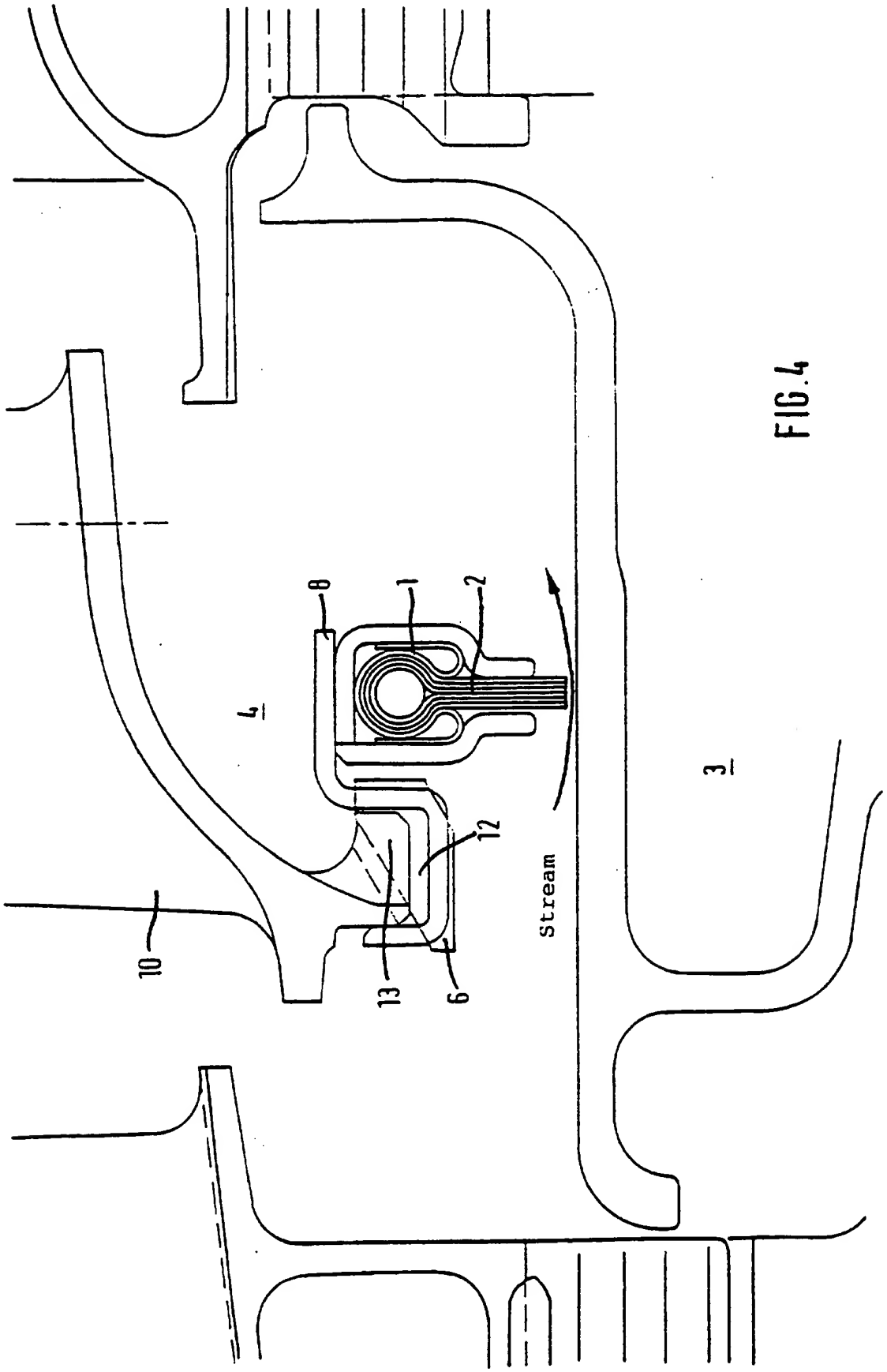

FIG.4

Sealing device for parts rotating relative to one another

The present invention relates to a sealing device for sealing the gap between parts rotating relative to one another, namely an inner part and an outer part, having a sealing element arranged between the inner part and the outer part and surrounding the inner part.

In propulsion unit construction, there are a number of cases of use in which two parts rotating relative to one another have to be sealed off from a gas stream passing through the propulsion unit. Such a case is, for example, sealing between the guide blades and the rotor of a jet propulsion unit.

In order to seal spaces in the form of annular gaps between propulsion unit parts rotating relative to one another, sealing devices are known wherein the sealing element comprises a brush seal and a seal carrier accommodating and carrying the brush seal and holding the brush seal on the outer of the two parts of the propulsion unit which are to be sealed off from one another.

Owing to the great temperature differences that may occur during the operation of a propulsion unit, especially, for example, between the rotor and the guide blades of a jet propulsion unit, relatively great changes in the radial gap width of the annular gap between the parts rotating relative to one another occur owing to the different degrees of heating and can be compensated for only partially by the resilient brush seals used nowadays.

The problem of the invention is therefore to provide a sealing device of the type required, especially for use in propulsion unit construction, which is capable of compensating for relatively great changes in the radial dimension of the space to be sealed.

This problem is solved in accordance with the present invention by a sealing device having the features indicated in Claim 1.

According to the invention, a sealing device is provided for sealing the space between two parts rotating relative to one another, namely an inner part and an outer part, and has a sealing element arranged between the inner part and the outer part and surrounding the inner part. According to the

invention, the sealing element is constructed as a part which surrounds the inner part in the form of a closed ring and which is arranged to be movable in the radial direction relative to the outer part. The advantage of designing the sealing element in the form of a closed ring is that the sealing element can expand independently in accordance with the temperature and can thus adapt itself better to the annular gap between the inner part and the outer part.

According to one embodiment of the invention, it is provided that the sealing element comprises a brush seal and a seal carrier, for holding the brush seal on the outer part, which are constructed as a unit surrounding the inner part in the form of a closed ring, the seal carrier being arranged to be movable in the radial direction relative to the outer part. This has the advantage that the brush seal is stabilised by the seal carrier and an inherently fixed sealing element is thereby formed. A further advantage is that the brush seal together with the seal carrier can be exchanged in a simple manner.

According to one embodiment, it is provided that the sealing device comprises a holding device in which the seal carrier is centred to be movable in

the radial direction relative to the outer part and is arranged to be secured against circumferential rotation.

According to a development of the above, it is provided that the holding device contains slide elements which are arranged on one of the inner part and the outer part and guide elements which are arranged on the other of the inner part and the outer part, the slide elements being centred to be movable in the radial direction and being arranged in the guide elements so that they are fixed against circumferential rotation. One advantage of this is that oscillations are damped by the friction occurring between the slide elements and the guide elements and thus the oscillation behaviour between the inner part and the outer part is improved.

According to one embodiment, the holding device comprises an abutment element which is in the form of a projection extending circumferentially and against which the seal carrier bears so that its position is fixed in the axial direction.

According to a further embodiment, it is provided that the slide elements are formed by sliding pads which are provided on the seal carrier and which

are arranged to be movable in the radial direction in grooves formed by the guide elements.

According to another embodiment, it is provided that the slide elements are provided by bow-shaped extensions of the seal carrier formed by a bent sheet metal part, which extensions are arranged to be movable in the radial direction in slots formed by the guide elements. The advantage of this embodiment is the low weight of the sealing device and reduced expenditure and thus favourable manufacturing costs.

According to a further embodiment, the holding device comprises a carrier ring which is provided on the seal carrier and which forms a recess opening radially outwards, wherein a projection extending circumferentially is provided on the outer part and engages in the recess of the carrier ring with radial play.

Finally, according to another embodiment, it is provided that guide elements are provided for each projection and are fixed on the carrier ring against circumferential displacement.

It is advantageous to use the sealing device according to the invention for sealing spaces in

the form of annular gaps between parts of a jet propulsion unit rotating relative to one another.

It is especially advantageous to use the sealing device according to the invention for sealing the annular gap between the rotor and the guide blades of a jet propulsion unit.

Embodiments of the invention are explained hereinafter with reference to the drawings, in which:

Figure 1 is a cross-sectional partial view of a sealing device according to a first embodiment of the invention arranged between the rotor and the guide blades of a jet propulsion unit;

Figure 2 is a plan view of the embodiment of Figure 1 in the direction of arrow A in Figure 1;

Figure 3 is a cross-sectional partial view of a sealing device according to a second embodiment of the invention arranged between the rotor and the guide blades of a jet propulsion unit; and

Figure 4 is a cross-sectional partial view of a sealing device according to a third embodiment of the invention arranged between the rotor and the guide blades of a jet propulsion unit.

In the first embodiment of the invention shown in cross-section in Figure 1, the sealing device according to the invention is used to seal an annular gap between an inner part 3 in the form of the rotor of the jet propulsion unit and an outer part 4 formed by a number of guide blade segments 10, from the stream running through the jet propulsion unit.

The sealing device contains a seal carrier 1 which is constructed as a substantially circular part carrying a brush seal 2. As is conventional in the prior art, the brush seal 2 is formed, for example, by several layers of a suitable heat-proof and resistant sealing material. The seal carrier 1 and the brush seal 2 together form a sealing element in the form of a closed ring which surrounds the inner part and which is arranged to be displaceable in a "floating" manner in the radial direction relative to the outer part 4.

An abutment element 9 in the form of a circumferential edge or bead coaxial with the inner part is provided on the outer part 4 and acts as a bearing face for the seal carrier 1 so that the position of the latter relative to the axial direction of the rotor is fixed, it being possible at the same time for the seal carrier 1 to move in the radial direction relative to the abutment element 9. The abutment element 9 is arranged on the downstream side of the stream which is to be sealed off by the sealing element, so that the forces caused by the stream and acting on the sealing element are absorbed by the abutment element 9. The abutment element 9 also fulfils the task of sealing the seal carrier 1 in the outer part 4 from the stream.

Slide elements 5 are formed on the opposite side of the seal carrier 1 to the abutment element 9 and cooperate with guide elements 6 formed on the outer part 4 in such a manner that, on the one hand, movement of the seal carrier 1 and thus of the brush seal 2 in the radial direction is possible and, on the other hand, the seal carrier 1 is prevented from rotating circumferentially. Thus, the guide elements 6 and the slide elements 5 provide for secure centring of the seal carrier. The slide elements 5 and the guide elements 6

form, together with the abutment element 9, a holding device for the sealing element formed by the seal carrier 1 and the brush seal 2, which holding device permits the sealing element a movement only in the radial direction in order to compensate for dimensional changes occurring as a result of differences in temperature.

As shown in Figure 2, the slide elements 5 are distributed at regular distances from one another over the circumference of the seal carrier 1. Two guide elements 6, by means of which the slide elements 5 are arranged to be displaceable in respect of movement in the radial direction and are fixed in respect of circumferential displacement, are provided, one on each side of each slide element 5, on each of the guide blade segments 10 which form the outer part 4 and each of which has the width B. For that purpose, the guide elements 6 are spaced from one another in such a manner that they leave free a groove 7 which is slightly wider than the slide element 5, so that the slide element 5 can slide to and fro in the radial direction between the guide elements 6 in the manner of a sliding or tenon block. Instead of the individual guide elements 6, it is also possible to provide a continuous circumferential collar which is interrupted by

axially extending grooves 7 and, as a result, forms circumferential shoulders.

In the second embodiment of the invention shown in Figure 3, the sealing device is used, as in the first embodiment, to seal an annular gap between an inner part 3 formed by a rotor of a jet propulsion unit and an outer part 4 formed by a number of guide blade segments 10. The seal carrier 1 is formed by a bent sheet metal part, one side of which bears against an abutment element 9 provided on the outer part 4. On the side lying opposite the abutment element 9, the sheet metal part forming the seal carrier 1 has bow-shaped extensions forming slide elements 5 which are arranged to be movable in the radial direction in slots formed by guide elements 6 provided on the outer part 4. The slide elements 5 and the guide elements 6 in turn cooperate with the abutment element 9 in the manner of a bearing which permits the seal carrier 1 and thus the brush seal 2 movement in the radial direction, but fixes the position of the seal carrier 1 relative to the axial direction of the rotor and prevents circumferential displacement of the seal carrier 1. The basic function is secure centring of the seal carrier 1 while at the same time permitting radial relative movement.

The third embodiment of the sealing device according to the invention shown in Figure 4 is also used to seal an annular gap between an inner part 3 formed by a rotor of a jet propulsion unit and an outer part 4 formed by guide blade segments 10. The seal carrier 1 is formed by a bent sheet metal part which carries the brush seal 2. A carrier ring 8 which is likewise in the form of a bent sheet metal part is arranged on the seal carrier 1 and forms a recess 12 which opens radially outwards and in which engages a projection 13 which extends circumferentially and which is provided on the outer part 4 or on each of the guide blade segments 10. In this embodiment, the carrier arrangement formed by the carrier ring 8 and cooperating with the projections 13 on the guide blade segments 10 is used both to fix the seal carrier 1 and thus the brush seal 2 relative to the axial direction of the rotor 3 and to permit movement of the seal carrier 1 in the radial direction. Guide elements 6, which, in the embodiment shown in Figure 4, are formed by small plates and are secured to the carrier ring 8, are provided for each of the projections 13 in order to prevent displacement or rotation of the seal carrier 1.

CLAIMS

1. Sealing device for sealing the gap between parts (3, 4) rotating relative to one another, an inner part (3) and an outer part (4), having a sealing element (1, 2) arranged between the inner part (3) and the outer part (4) and surrounding the inner part (3), which sealing element (1, 2) is in the form of a closed ring and is arranged to be movable in the radial direction relative to the outer part (4), characterised in that the seal carrier (1) of the sealing element (1, 2) is arranged in a holding device (5, 6, 9; 6, 8, 13) which is formed by slide elements arranged on one of the inner part (3) and the outer part (4), and guide elements arranged on the other of the inner part (3) and the outer part (4), wherein the slide elements (5) are distributed over the circumference of the seal carrier (1) and are centred in the guide elements to be movable in the radial direction.

2. Sealing device according to Claim 1, characterised in that the sealing element (1, 2) comprises a brush seal (2) which is held in the seal carrier (1).

3. Sealing device according to Claim 1 or 2, characterised in that the holding device (5, 6, 9) comprises an abutment element (9) which is in the form of a projection extending circumferentially and against which the seal carrier (1) bears in a flat and sealing manner so that its position is fixed in the axial direction.

4. Sealing device according to Claims 1 to 3, characterised in that the slide elements (5) are formed by sliding pads which are provided on the seal carrier (1) and which are arranged to be movable in the radial direction in grooves (7) formed by the guide elements (6).

5. Sealing device according to Claims 1 to 3, characterised in that the slide elements (5) are provided by bow-shaped extensions of the seal carrier (1) formed by a bent sheet metal part, which extensions are arranged to be movable in the radial direction in slots formed by the guide elements (6).

6. Sealing device according to Claim 1, characterised in that the holding device (6, 8, 13) comprises a carrier arrangement (8) which is provided on the seal carrier (1) and which forms a recess (12) opening radially outwards, and in that

a projection (13) extending circumferentially is provided on the outer part (4) and engages in the recess (12) of the carrier ring (8) with radial play.

7. Sealing device according to Claim 6, characterised in that guide elements (6) which are fixed on the carrier ring are provided for each projection (13).

8. Use of a sealing device according to any one of Claims 1 to 7 for sealing the annular gap between parts of a jet propulsion unit rotating relative to one another.

9. Use of a sealing device according to any one of Claims 1 to 7 for sealing the annular gap between the rotor and the guide blades of a jet propulsion unit.

The Patent Office

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Application No: GB 9711244.5 **Examiner:** R L Williams
Claims searched: 1-9 **Date of search:** 7 August 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): F2B

Int Cl (Ed.6): F16J 15/32,15/44,15/447

Other: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	GB 1,220,904	Westinghouse Electric Corporation (note pins 45)	1 and 2
A	WO 92/05378 A1	Cross Manufacturing Company	1

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.